Chromium Doped Zn-Ferrites Catalyzed Synthesis, Spectral Characterization, X-Ray Diffraction and Biological Applications of Nitro Phenyl Benzamides

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Abstract: The research work focuses on Chromium doped Zn-ferrites catalyzed synthesis of 3 and 4 - Nitro phenyl benzamides, obtained in high yield. The synthesized compounds were characterized and confirmed by various spectral techniques like UV-Vis, ^{1}H-NMR, Mass measurements etc. XRD analysis was also done and by applying the Debye Scherrer's formula, the average particle size of the nitro phenyl benzamides was calculated. The synthesized nitro phenyl benzamides were screened for their biological activities.

Keywords: *Chromium doped Zn-ferrites catalyst, Synthesis, spectral characterization, Nitro phenyl benzamides*

I. INTRODUCTION

Amides are very important class of organic molecules; they can be prepared from carboxylic acids, acyl chlorides (acid chlorides) and acid anhydrides. Designing, spectral characterizing of different derivatives of benzamides and exploring their applications in various fields is of recent research interest. Very recently derivatives of benzamides have been reported as anti microbial agents, as promising anti oxidant agents, anti cancer agents, as potential antitumor agents for the treatment of multiple myeloma (MM), as anti-tubercular agents [1-6]. The main goal of green chemistry is to have high yield (high atom economy) in the reaction, solvent free or less usage of solvent in reaction, avoiding multi steps in a reaction, use of catalysts in a reaction, microwave irradiation for reaction etc [7-11].

In our earlier studies Cr doped Zn Ferrites were prepared and its structural characteristics were explored [12]. Cr doped Zn Ferrites are experimented for dye decolourization and dye

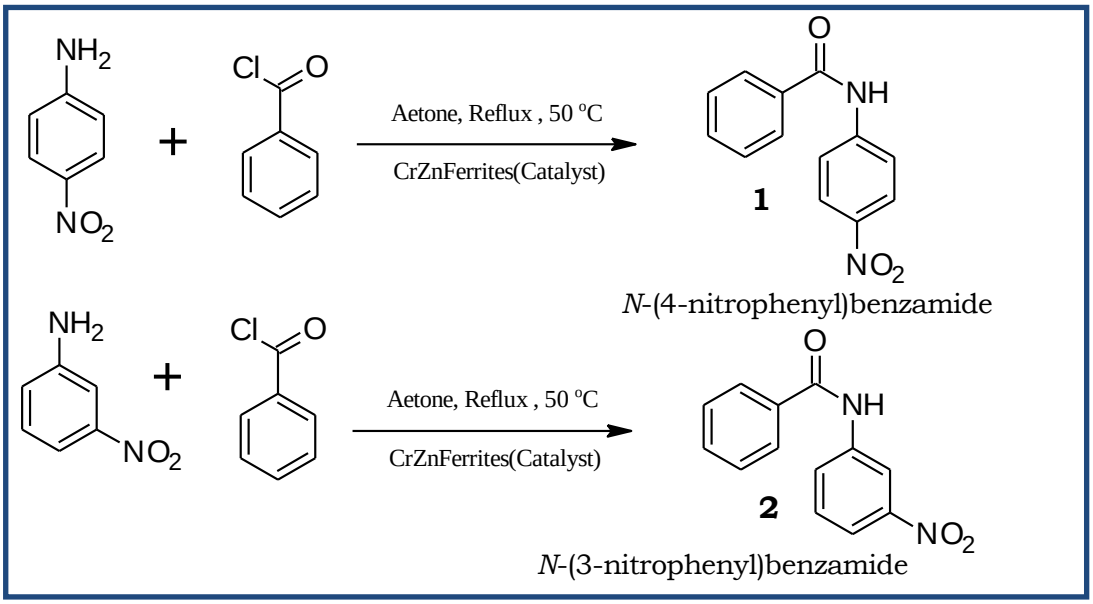
degradation studies. In continuation, the present research developed for the synthesis of Nitro phenyl benzamides in presence and absence of Cr doped Zn Ferrites as catalyst.

II. METHODS AND MATERIALS/CHEMICALS

Different nitro-anilines and benzoyl chloride were purchased from S D-fine chemical suppliers, India and were directly used as such for reactions. The other chemicals (solvents) used for the synthetic purpose are of pure analytical reagent grade obtained from Himedia chemical suppliers. Cr doped Zn Ferrites used was synthesized according reported literature [12]. The UV-Visible absorption spectra were recorded in, DMSO solvent with a 'SHIMADZU UV-Visible-1650' spectrometer in the wavelength range of 200-800 nm. Infrared spectra of synthesized compounds were recorded in the region of 400 cm^{-1} to 4000 cm^{-1} on a FTIR-460 Spectrometer in KBr pellets. The mass spectra were recorded with a LC-MS-trap-XCT plus mass spectrometer. The ^{1}H NMR spectra were recorded in DMSO-d_6 at 400MHz using AMX-400 FT-NMR spectrophotometer using TMS as an internal standard.

III. SYNTHETIC PROCEDURE

1g of 4-nitroaniline, 15ml acetone, 0.2g of Chromium doped Zn-ferrites and 2 ml of benzoyl chloride were taken in the two necked round bottomed flask fitted with a thermometer and condenser. Contents were refluxed at 50-60 ^{o}C for about 30 minutes on water bath, removed the round bottom flask from the water bath and quenched in Crushed ice and a precipitate formed was filtered with help of suction pump and dried and separated the catalyst from the product obtained. The yield obtained was 82%. Where as in the absence of Chromium doped Zn-ferrites the %yield obtained was 69. Similar procedure was employed for the preparation of 3 nitro phenyl benzamide The yield obtained was 79%. Where as in the absence of Chromium doped Zn-ferrites the %yield obtained was 68. Recrystalization: The product obtained and acetone were taken in the round bottom flask and refluxed for about 10-15 minutes on water bath, filtered with the whatmann filter paper the filtrate was collected, dried the filtrate, solid obtained in the watch glass was recrystalised sample and used for spectral confirmation . Synthetic route of title compounds was shown in Scheme-1



Scheme-1: Synthetic path of Nitrophenyl benzamide

Synthetic compounds are positional isomers. i.e the compounds having same molecular formula but position of one of functional group is different. Hence data of both the molecules are appears to be same.

Calculated data of N-(Nitrophenyl) Benzamide

Molecular Formula = $C_{13}H_{10}N_2O_3$
Formula Weight = 242.2301
Composition = C(64.46%) H(4.16%) N(11.56%) O(19.82%)
Molar Refractivity = 67.37 ± 0.3 cm^3
Molar Volume = 180.1 ± 3.0 cm^3
Parachor = 502.3 ± 4.0 cm^3
Index of Refraction = 1.671 ± 0.02
Surface Tension = 60.4 ± 3.0 dyne/cm
Density = 1.344 ± 0.06 g/cm^3
Polarizability = 26.70 ± 0.5 $10^{-24}cm^3$
Monoisotopic Mass = 242.069142 Da
Nominal Mass = 242 Da

IV. RESULTS AND DISCUSSIONS

UV-Visible Spectra: UV-Visible Spectra of the synthesized compounds were recorded in, DMSO solvent with a 'SHIMADZU UV-Visible-1650' spectrometer in the wavelength range of 200-800 nm. As the compounds are not colored they shows peaks within the UV region i.e 200-400nm. As energy and wavelength are inversely proportional, the peak corresponding to higher wavelength 350nm was assigned for less energy transition i.e $n-\pi*$. $\pi-\pi*$ is for high energy transition corresponding wavelength 270 nm and lesser wavelength 230nm is assigned for $\sigma-\sigma*$ high energy transition. UV-Visible spectrum of compound 1 was shown in figure-1.

Infrared spectra: Infrared spectra of synthesized compounds were recorded in the region of 400 cm^{-1} to 4000 cm^{-1} on a FTIR-460 Spectrometer in KBr pellets. Infrared spectra of synthesized compound shows three major peaks corresponding to -C=O, -NH, and C=C groups respectively. Other peaks were assigned for skeletal vibration of the molecule. IR spectrum of compound 1 was shown in figure-2.

NMR and Mass Spectral Data: The ^{1}H NMR spectra were recorded in DMSO-d_6 at 400MHz using AMX-400-NMR spectrophotometer using TMS as an internal standard The mass spectra were recorded with a LC-MS-trap-XCT plus mass spectrometer. ^{1}H NMR spectrum and mass spectrum was shown in figures 3-5. N-(4-nitrophenyl) benzamide molecule has total ten protons, out of which 9 proton are aromatic, appeared at 7.44 to 8.17 δppm and one proton is –NH proton is variable and is appeared at 8.6 δppm in the spectrum. The mass spectrum also confirms the molecule by showing molecular ion peak 240.94 m/z value with high % of relative abundance.

X-ray diffraction studies: The powder X-ray diffraction patterns N-(nitrophenyl) benzamide molecule are obtained using Cu – Kα radiation (λ=1.542A˚). Powder X-ray diffraction methods based on the study of the pattern of diffracted rays produced when monochromatic beam strikes the molecules. The degree of crystallinity of the sample can be determined using X- ray powder patterns. The non crystalline portion simply scatters the X-rays to give a continuous base line or background. The average crystallinity of the samples were calculated by using Scherer's formula D = Kλ/βcosθ, where D is the average crystalline size, λ is the

wavelength of the X- ray irradiation, K is constant usually taken as 0.89, β is the full width half maxima (FWHM) of diffraction peak corrected for the instrumental line broadening using silicon as a standard and θ angle of diffraction. it was found that the Nitro phenyl benzamides (14-24nm) are relatively poor crystalline in nature. X-ray diffraction pattern was shown in figure -6 and corresponding data are tabulated in table-1

Biological activity

The antimicrobial activity of the compounds were screened by agar well radial diffusion method against bacterial strains belonging to Escherchia coli. Preparation of nutrient agar (Solid media for bacterial growth) volume 150ml. Chemicals used for agar media are Sodium chloride crystals, Beef extract powder for bacteriology, Peptone powder (crystalline), Agar Agar Type-1. Weighed and dissolved 0.750gm (0.5% W/V) NaCl, 0.450gm (0.3%W/V) beef extract, 0.750gm (0.5%W/V) peptone powder in 100ml of water and stirred it well in a container. pH of the solution was noted and maintained ~7. Added 3gm of (2% W/V) Agar and diluted the volume to150mL. Thus nutrient agar was prepared and used for biological activity. Experimental result reveals that nitrophenyl benzamide shown good antibacterial character.

Conclusions: Chromium doped Zn-ferrites catalyzed high yield synthesis of 3 and 4 - Nitro phenyl benzamides were reported in the present research work. The synthesized compounds were confirmed spectral techniques like UV-Vis, ^{1}H-NMR, Mass measurements etc. from the XRD studies reveals that (calculated by Debye Scherrer's formula), the average particle size of the nitro phenyl benzamides was found to be in the nm range. The synthesized nitro phenyl benzamides were screened for their biological activities. Nitro phenyl benzamides shown better response in anti bacterial activities.

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Declaration of conflict Interest: The authors declared that there is no conflict of interest.

References:

1. *Cemre Acar, Gozde Yalçın, Tuğba Ertan-Bolelli, Fatma Kaynak Onurdağ, Suzan Ökten, Funda Şener, İlkay Yıldız, Synthesis and molecular docking studies of some novel antimicrobial benzamides, Bioorganic Chemistry,Volume 94,2020,103368 https://doi.org/10.1016/j.bioorg.2019.103368*

2. *Shuxiao Feng, Kaiyan Qi, Yafei Guo, Junling Wang, Guangna Gu, Pu Liu, Junying Ma, Lingbo Qu, Shouren Zhang, A novel synthesis of 2-((2-oxopropyl)selanyl) benzamide derivatives by cascade selenenylation-acylation reaction and in vitro cytotoxicity evaluation,Tetrahedron Letters,Volume 61, Issue 48,2020,152561, https://doi.org/10.1016/j.tetlet.2020.152561*

3. *Mohd Abdullaha, Vijay K. Nuthakki, Sandip B. Bharate, Discovery of methoxy-naphthyl linked N-(1-benzylpiperidine) benzamide as a blood-brain permeable dual inhibitor acetylcholinesterase and butyrylcholinesterase, European Journal of Medicinal Chemistry,Volume 207,2020,112761 https://doi.org/10.1016/j.ejmech.2020.112761*

4. *Xin-yang Li, Shuai Li, Guo-qing Lu, De-pu Wang, Kai-li Liu, Xin-hua Qian, Wen-han Xue, Fan-hao Meng, Design, synthesis and biological evaluation of novel (E)-N-phenyl-4-(pyridine-acylhydrazone) benzamide derivatives as potential antitumor agents for the treatment of multiple myeloma (MM), Bioorganic Chemistry, Volume 103, 2020, 104189, https://doi.org/10.1016/j.bioorg.2020.104189*

5. *I. Novak Jovanović, A. Miličević, D. Jadreško, M. Hranjec, Electrochemical oxidation of synthetic amino-substituted benzamides with potential antioxidant activity, Journal of Electroanalytical Chemistry, Volume 870, 2020, 114244, https://doi.org/10.1016/j.jelechem.2020.114244*

6. *Satyaveni Malasala, Md Naiyaz Ahmad, Jitendra Gour, Manjulika Shukla, Grace Kaul, Abdul Akhir, Srikanth Gatadi, Y.V. Madhavi, Sidharth Chopra, Srinivas Nanduri, Synthesis, biological evaluation and molecular modelling insights of 2-arylquinazoline benzamide derivatives as anti-tubercular agents, Journal of Molecular Structure, Volume 1218, 2020, 128493, https://doi.org/10.1016/j.molstruc.2020.128493*

7. *Vesna M. Milovanović, Zorica D. Petrović, Slađana Novaković, Goran A. Bogdanović, Vladimir P. Petrović, Dušica Simijonović, Green synthesis of benzamide-dioxoisoindoline derivatives and assessment of their radical scavenging activity –*

Experimental and theoretical approach, Tetrahedron, Volume 76, Issue 38, 2020, 131456, https://doi.org/10.1016/j.tet.2020.131456

8. *Motakatla Novanna, Sathananthan Kannadasan, Ponnusamy Shanmugam, Phosphotungstic acid mediated, microwave assisted solvent-free green synthesis of highly functionalized 2ˈ-spiro and 2, 3-dihydro quinazolinone and 2-methylamino benzamide derivatives from aryl and heteroaryl 2-amino amides, Tetrahedron Letters, Volume 60, Issue 2, 2019, https://doi.org/10.1016/j.tetlet.2018.12.011*

9. *Monica Becker, Joel A. Tickner, Driving safer products through collaborative innovation Lessons learned from the Green Chemistry & Commerce Council's collaborative innovation challenge for safe and effective preservatives for consumer products, Sustainable Chemistry and Pharmacy, Volume 18, 2020, 100330, https://doi.org/10.1016/j.scp.2020.100330*

10. *Monika Verma, Renu Sharma, Ruchi Bharti, Amanpreet Tangri, Green one-pot synthesis of N-based heterocycles involving o-phenylenediamine, Materials Today: Proceedings, 2020, https://doi.org/10.1016/j.matpr.2020.07.733*

11. *R.A. Shoukat Ali, J. Keshavayya, A.S. Jagadisha, S.D. Umesh, Copper (II) phthalocyanines: Electrode modification and sensing studies, Materials Today: Proceedings, 2020, https://doi.org/10.1016/j.matpr.2020.07.017*

12. *P.G. Prashanth Kumar, R.A Shoukat Ali, A.S. Jagadisha, S.D. Umesh, Synthesis and studies of Cr doped Zn ferrites, Materials Today: Proceedings, 2020, https://doi.org/10.1016/j.matpr.2020.07.014*

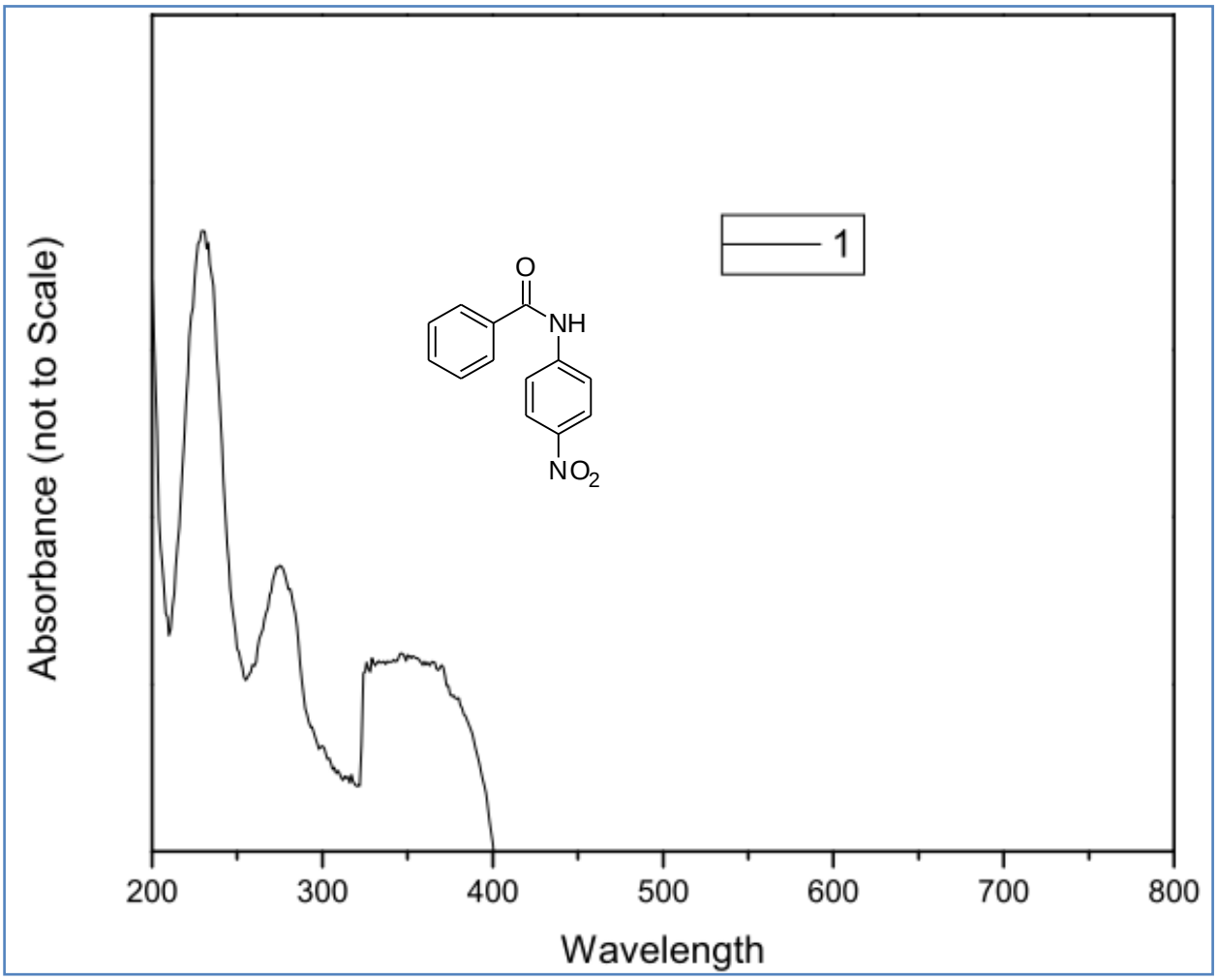

Figure-1: UV-Visible Spectrum of N-(4-nitrophenyl) benzamide

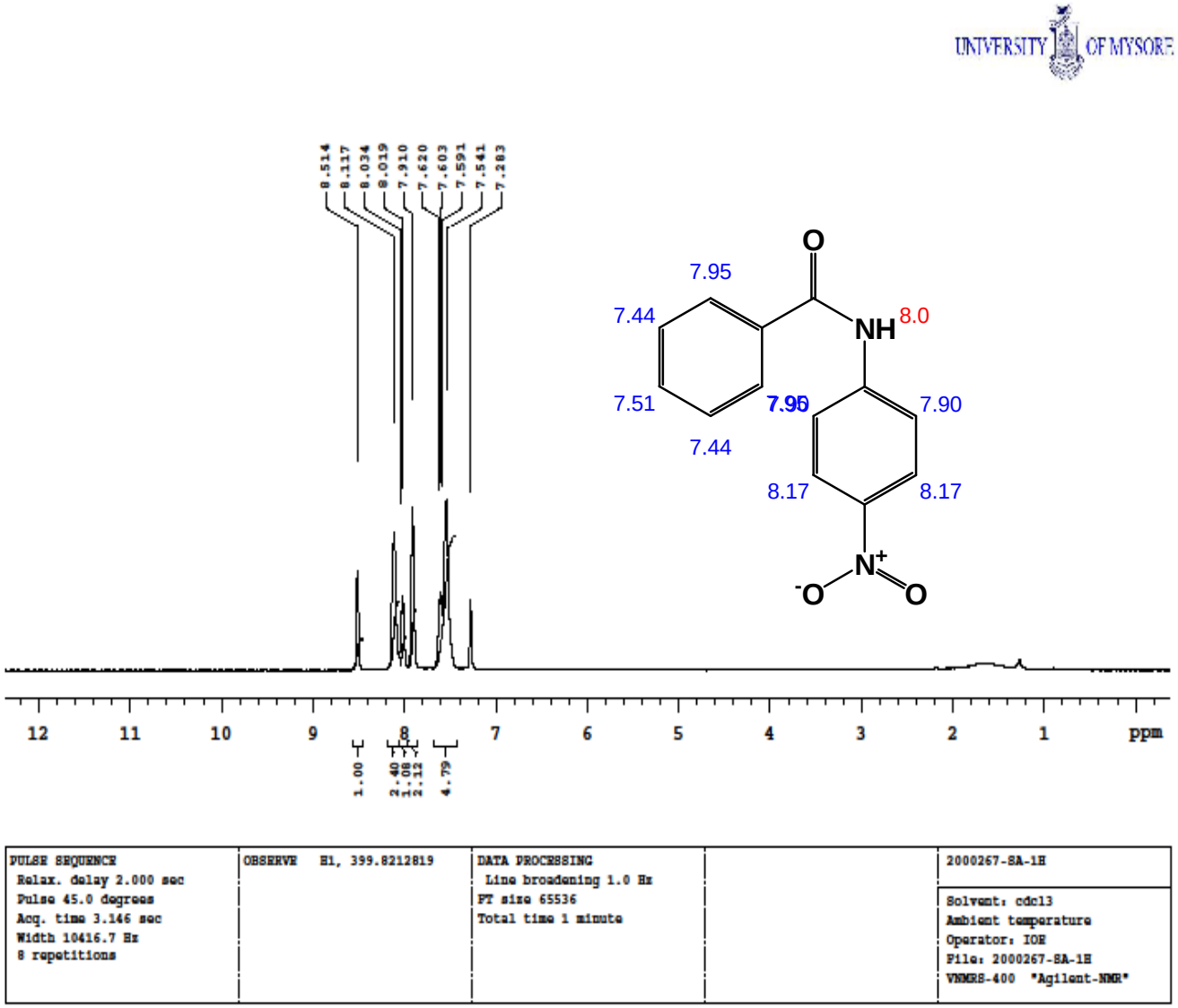

Figure-3: ^{1}H NMR Spectrum of N-(4-nitrophenyl) benzamide

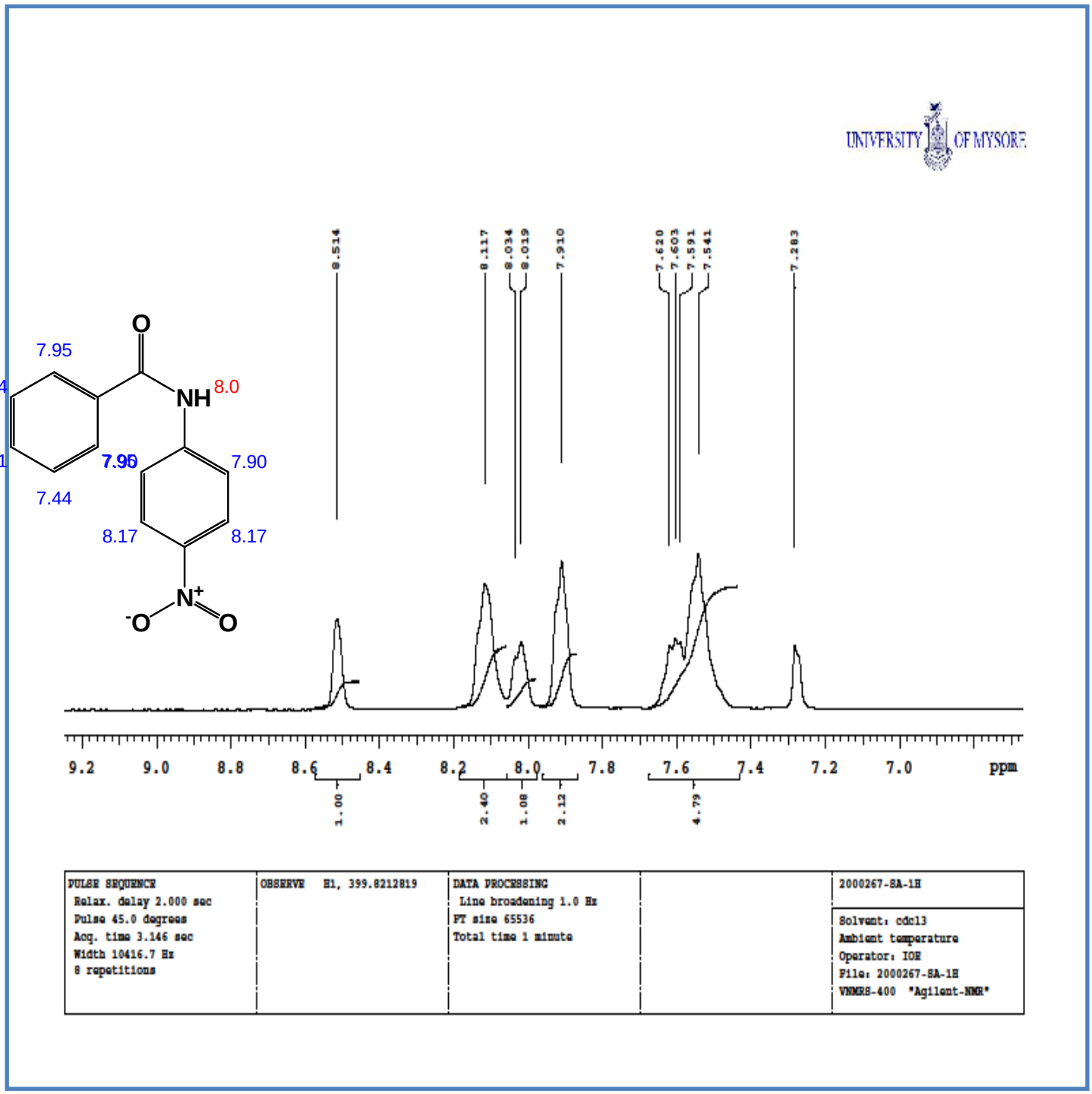

Figure-4: Integrated ^{1}H NMR Spectrum of N-(4-nitrophenyl) benzamide

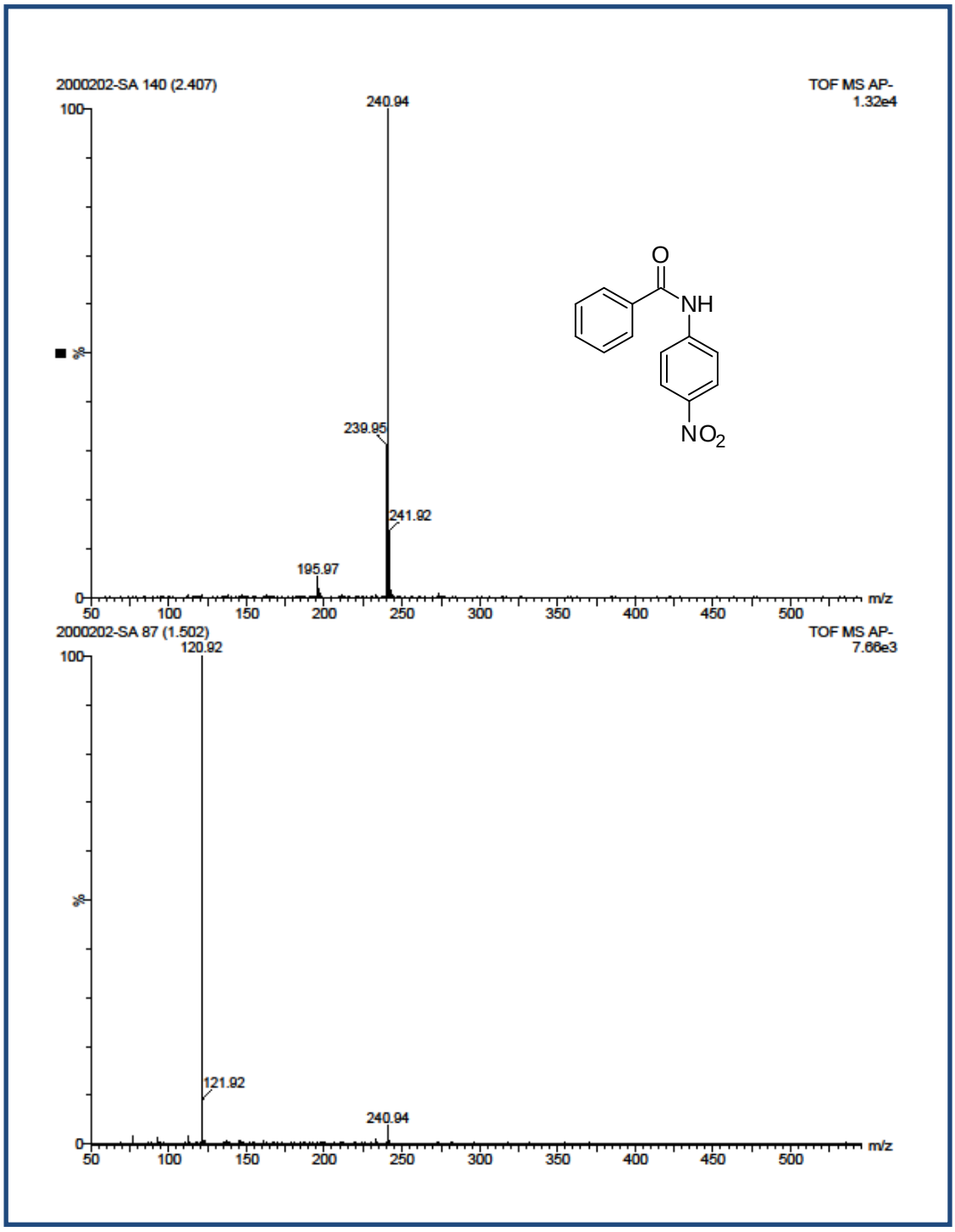

Figure-5: Mass spectrum of N-(4-nitrophenyl) benzamide

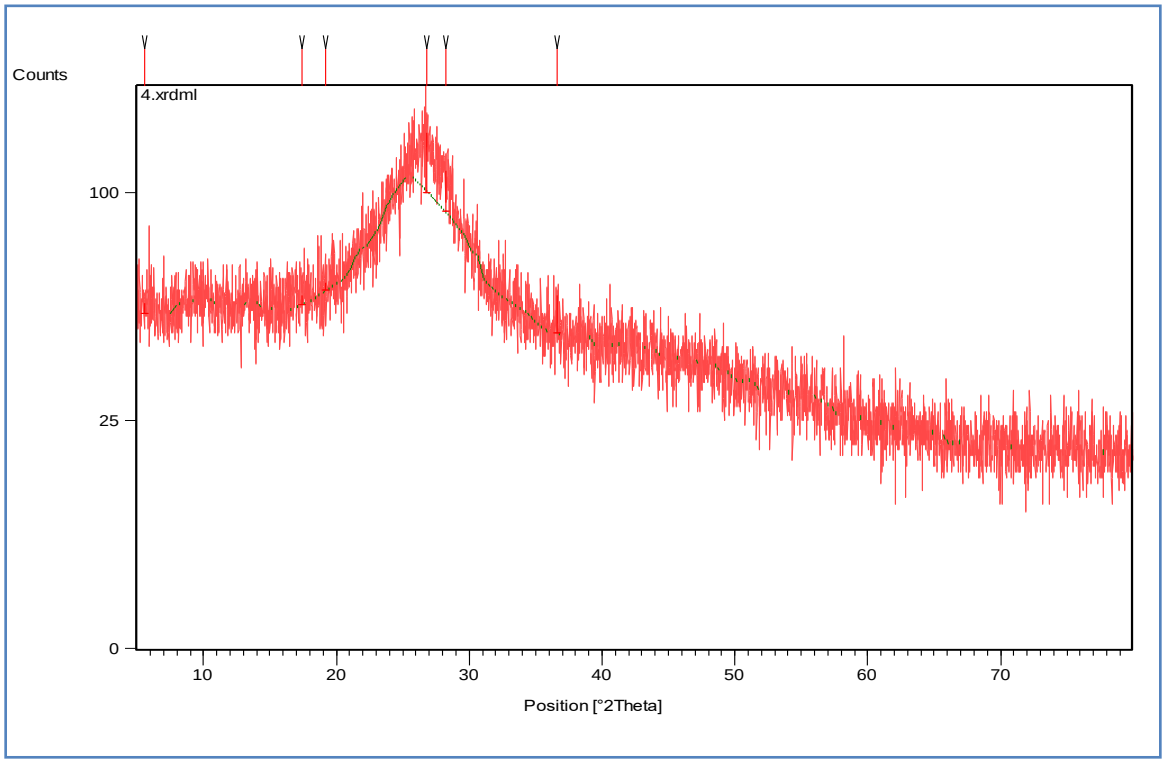

Figure-: X-ray diffraction pattern of 4-nitrophenyl benzamide

[°2Th.]	Height [cts]	FWHM [°2Th.]	d-spacing [Å]	Rel. Int. [%]
5.5827	3.71	0.8028	15.83062	13.22
17.4551	3.17	0.4015	5.08079	11.30
19.1630	2.68	0.1004	4.63163	9.54
26.8040	28.05	0.5353	3.32613	100.00
28.2103	17.93	0.8028	3.16344	63.91
36.6558	12.26	0.1673	2.45167	43.70

Table-1-: X-ray diffraction data of 4-nitrophenyl benzamide